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Solid-State Thyratron Replacement

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The thyratron has been used as a switch in pulsed-power applications for almost a century. In the last 20 years, as a result of developments pioneered at DTI, most new modulator applications have transitioned away from thyratrons to solid-state switching. As the cost and capabilities of solid-state modulators has improved, their adoption has grown rapidly. With the continued evolution and reliability of solid-state pulsed-power systems, virtually all new pulsed-power systems are designed around solid-state capabilities.

Thyratrons have a lifetime of only ten to twenty thousand hours and require periodic adjustment of their reservoir heater voltage. The solid-switch's extremely long life and reliability offers an attractive replacement opportunity for many thyratron-based systems, with orders of magnitude longer lifetime and no regular maintenance. Replacing thyratrons with solid-state switches that last 20 years or more without maintenance would enable significant savings over an accelerator's life. Until recently, however, solid-state switches have not historically been capable of handling the voltage, current, and risetime required to replace thyratrons.

Under a recently completed DOE Phase II SBIR, DTI has developed and demonstrated a thyratron replacement switch for the SLAC National Accelerator Laboratory. Unlike the series string of insulated-gate bipolar transistors (IGBTs) used in most of DTI's modulators, this switch was designed using arrays of series- and parallel-connected commercial IGBTs. It has successfully demonstrated full operating capability at the SLAC thyratron specifications of 48 kV, 6.3 kA, and 1 µs risetime. In addition, the switch has the potential to improve accelerator performance by reducing peak-to-peak pulse jitter to a level five times shorter than is typical for thyratrons. This demonstrated jitter of 1.5 ns has the potential to significantly improve the performance of the Linac Coherent Light Source (LCLS) beam, and increase the HV stability in the accelerator.

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